US009003887B2

(12) United States Patent
Matsumoto

(10) **Patent No.: US 9,003,887 B2**
(45) **Date of Patent: Apr. 14, 2015**

(54) **ULTRASONIC SENSOR**

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(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 894 days.

(21) Appl. No.: **13/114,521**

(22) Filed: **May 24, 2011**

(65) **Prior Publication Data**

US 2011/0290028 A1 Dec. 1, 2011

(30) **Foreign Application Priority Data**

May 28, 2010 (JP) 2010-123601
Mar. 23, 2011 (JP) 2011-063512

(51) **Int. Cl.**
G10K 9/22 (2006.01)
G10K 9/122 (2006.01)

(52) **U.S. Cl.**
CPC . ***G10K 9/22*** (2013.01); ***G10K 9/122*** (2013.01)

(58) **Field of Classification Search**
CPC G10K 9/22; G10K 9/122
USPC 73/632, 645–646; 310/323.21, 324, 310/334, 336, 345
See application file for complete search history.

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(57) **ABSTRACT**

An ultrasonic sensor includes a cylindrical case having a bottom and a side wall, a piezoelectric element attached to an inner bottom surface of the case, a terminal retainer configured to hold outer terminals and inner terminals, and wires connected to the inner terminals and configured to feed power to the piezoelectric element. The side wall of the case has a thin portion adjacent to an opening of the case and a thick portion adjacent to the bottom of the case. The elastic member is provided between the thick portion and the terminal retainer. An opening region surrounded by the thick portion is preferably covered with the elastic member. The case is preferably internally filled with a filler.

11 Claims, 8 Drawing Sheets

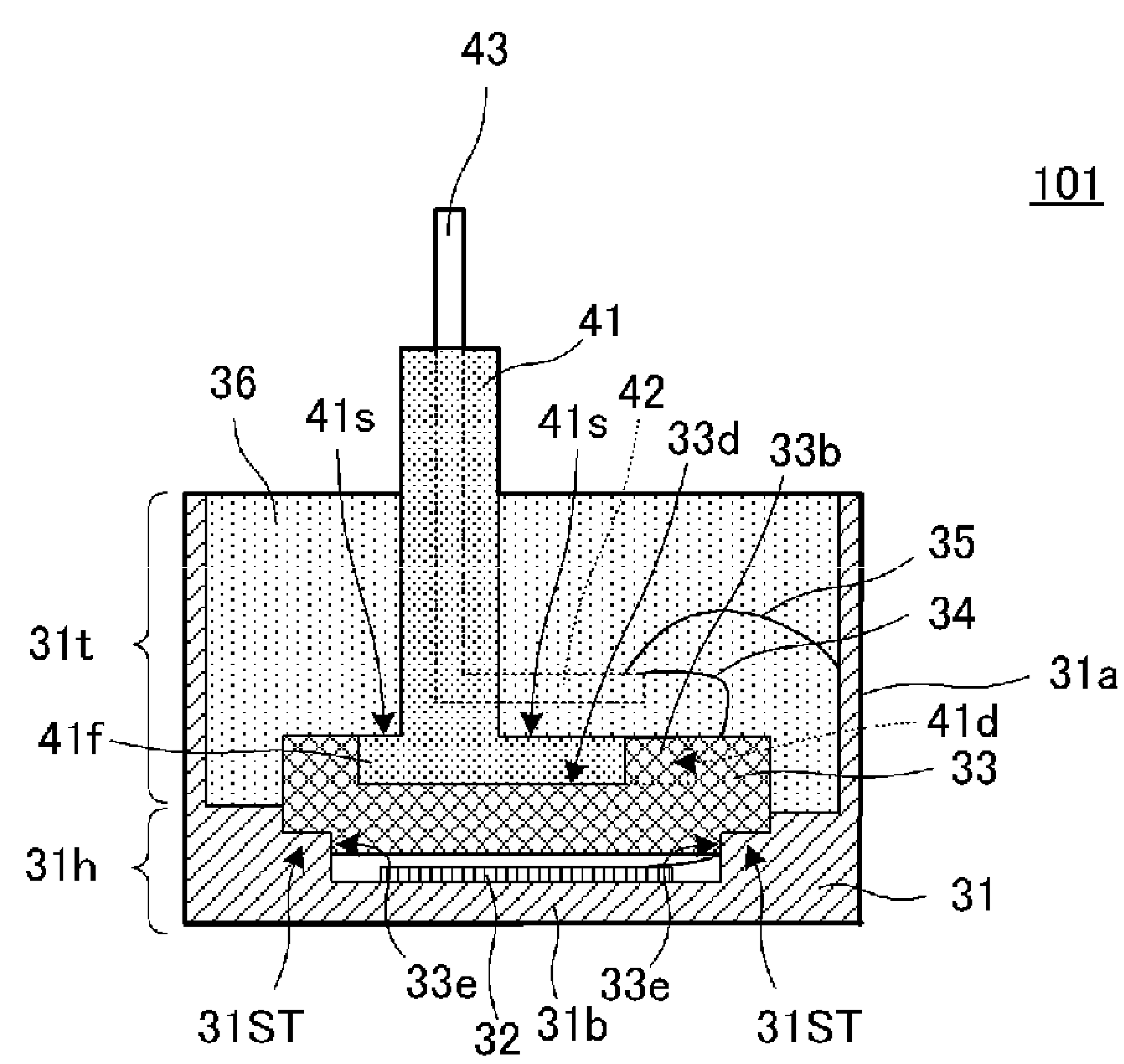

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FIG. 1
PRIOR ART

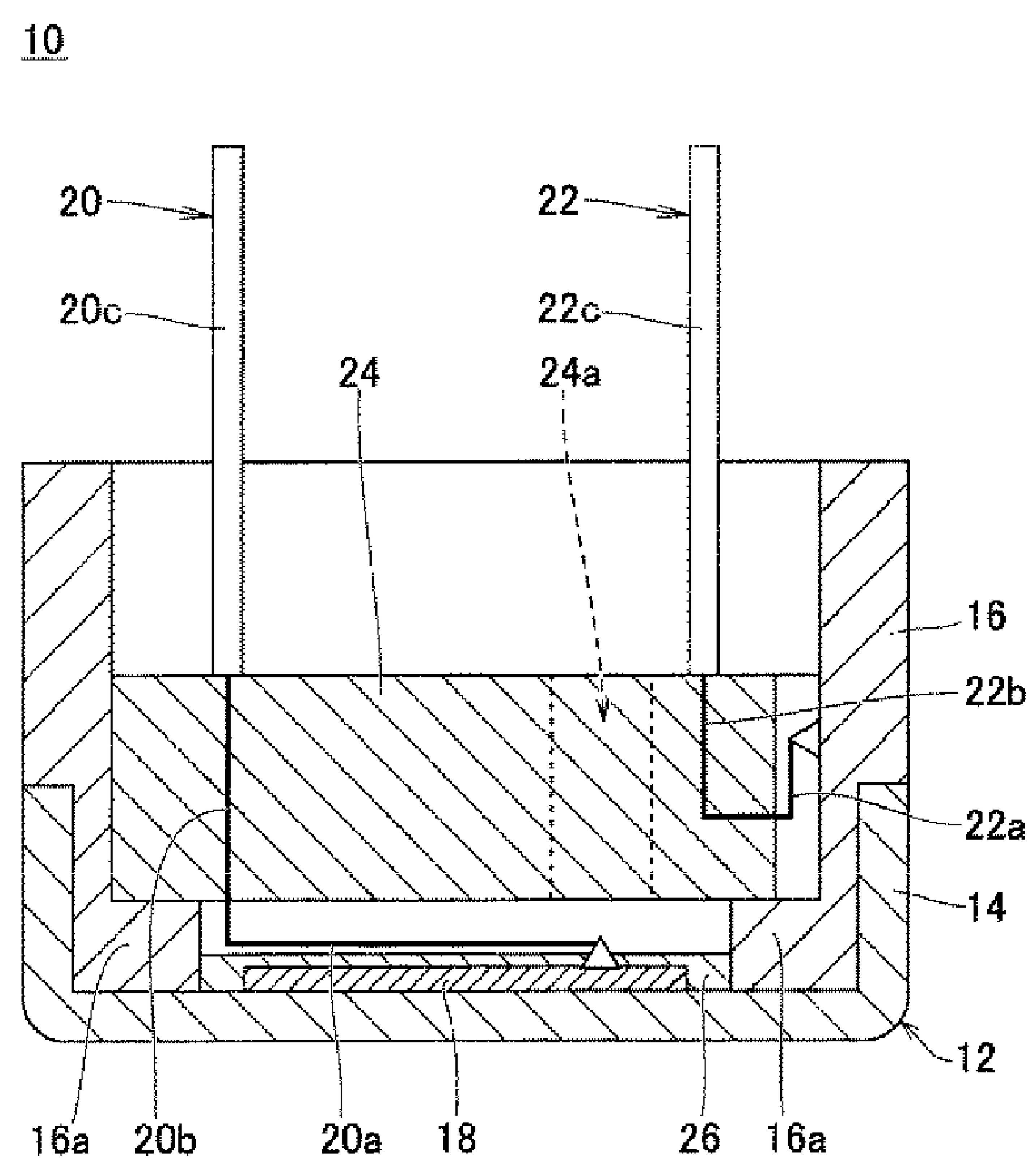
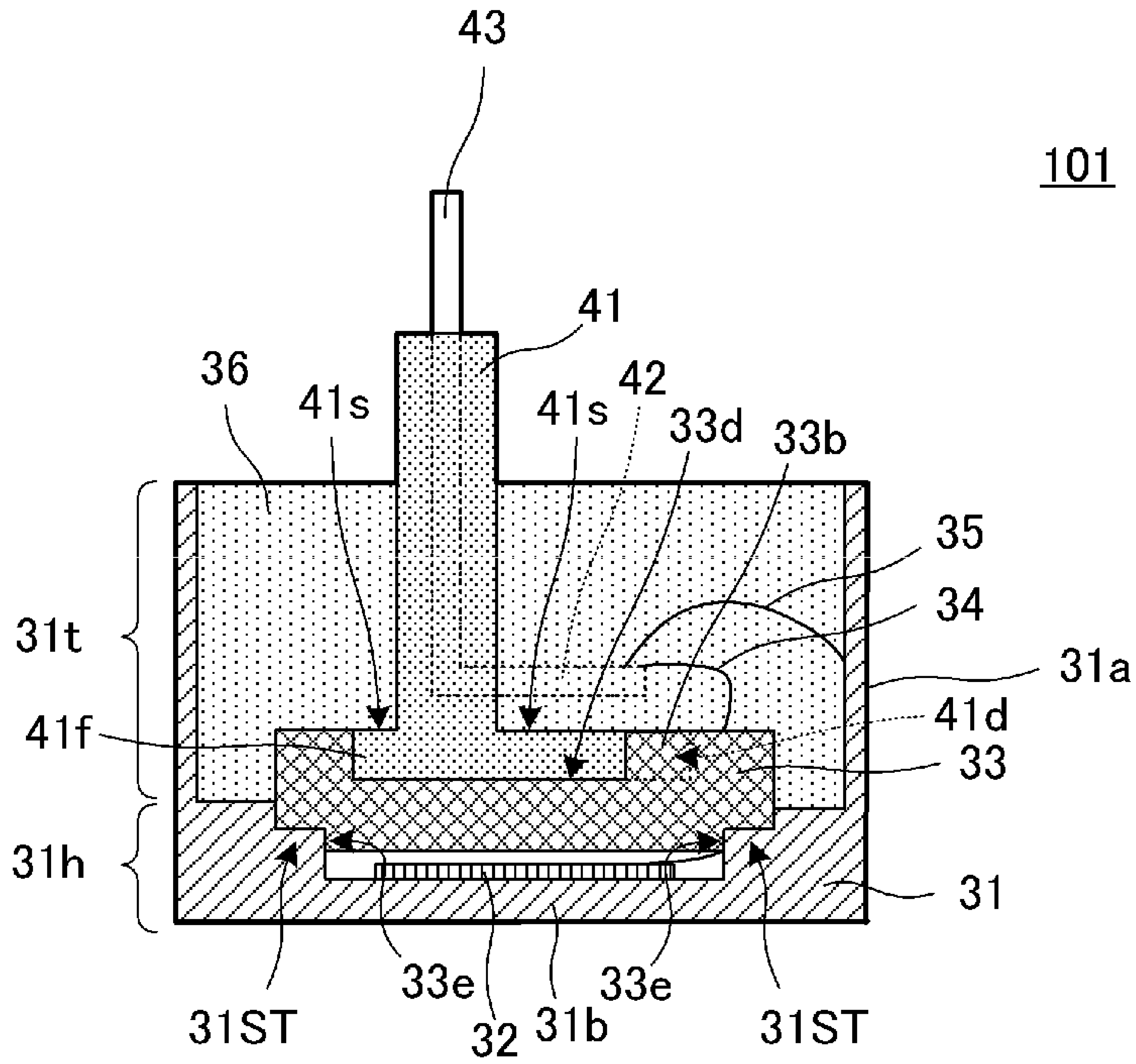


FIG. 2A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101
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41s
41s
42
33d
33b
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34
31t
31a
41d
41f
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31
33e
33e
31ST
31ST
32
31b

FIG. 2B

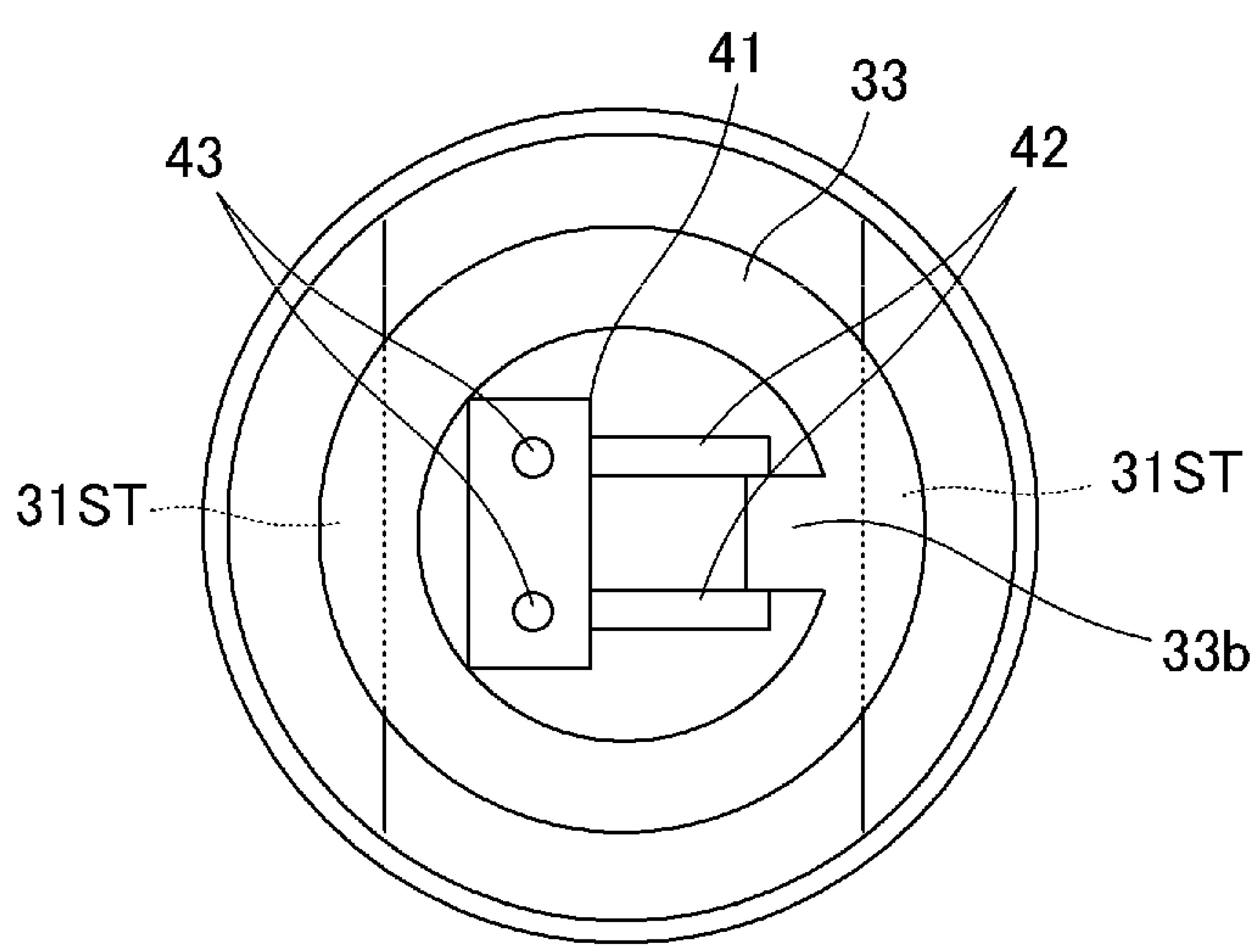

41
33
43
42
31ST
31ST
33b

FIG. 3

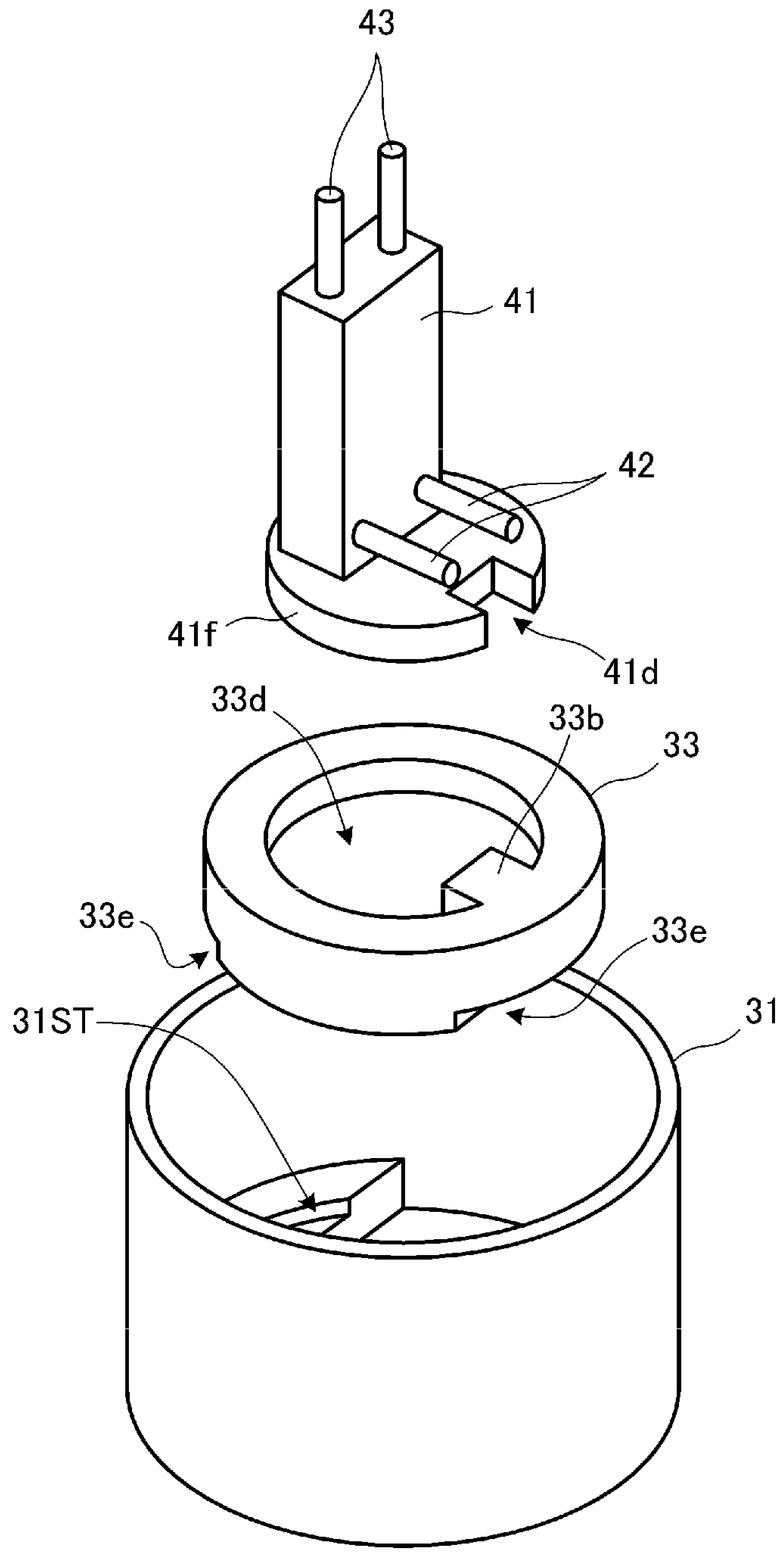


FIG. 4A

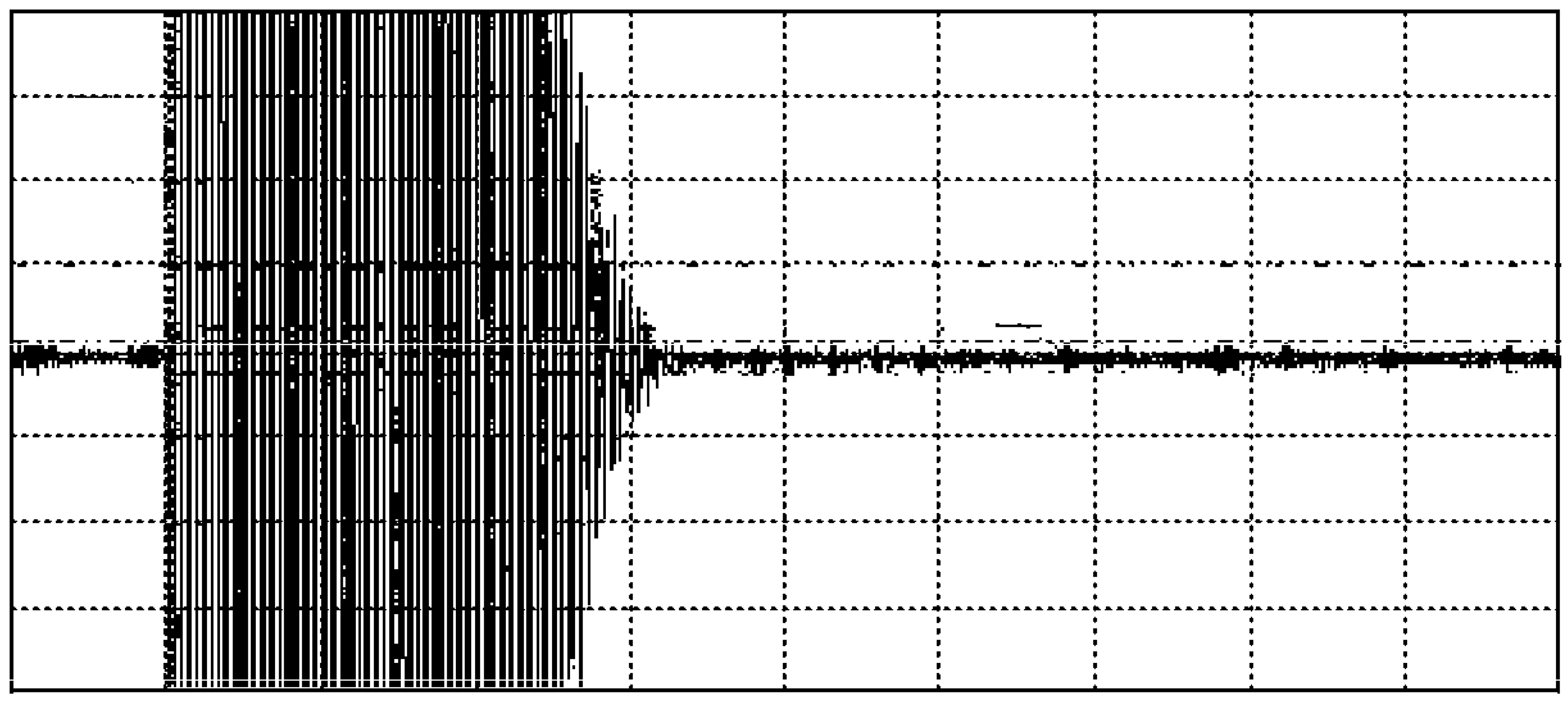


FIG. 4B

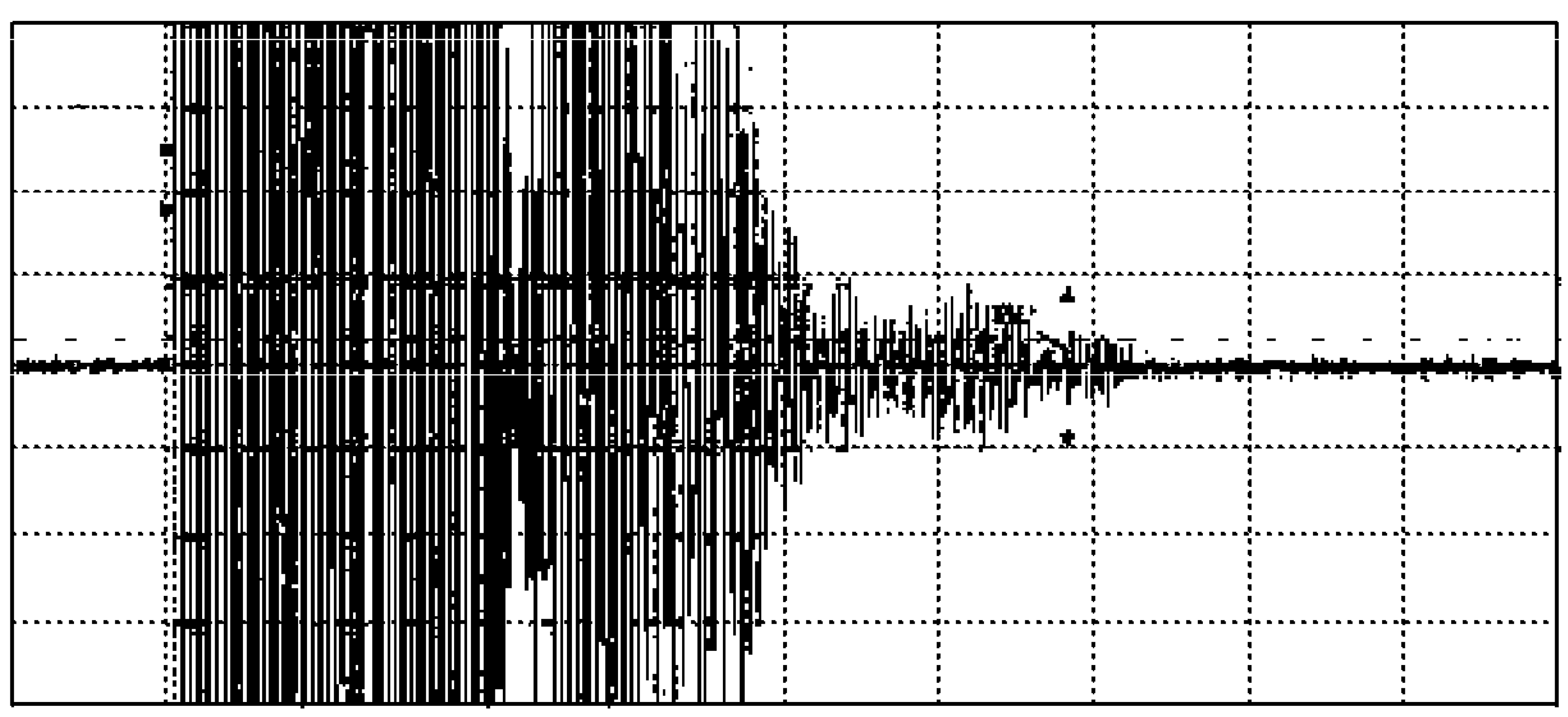
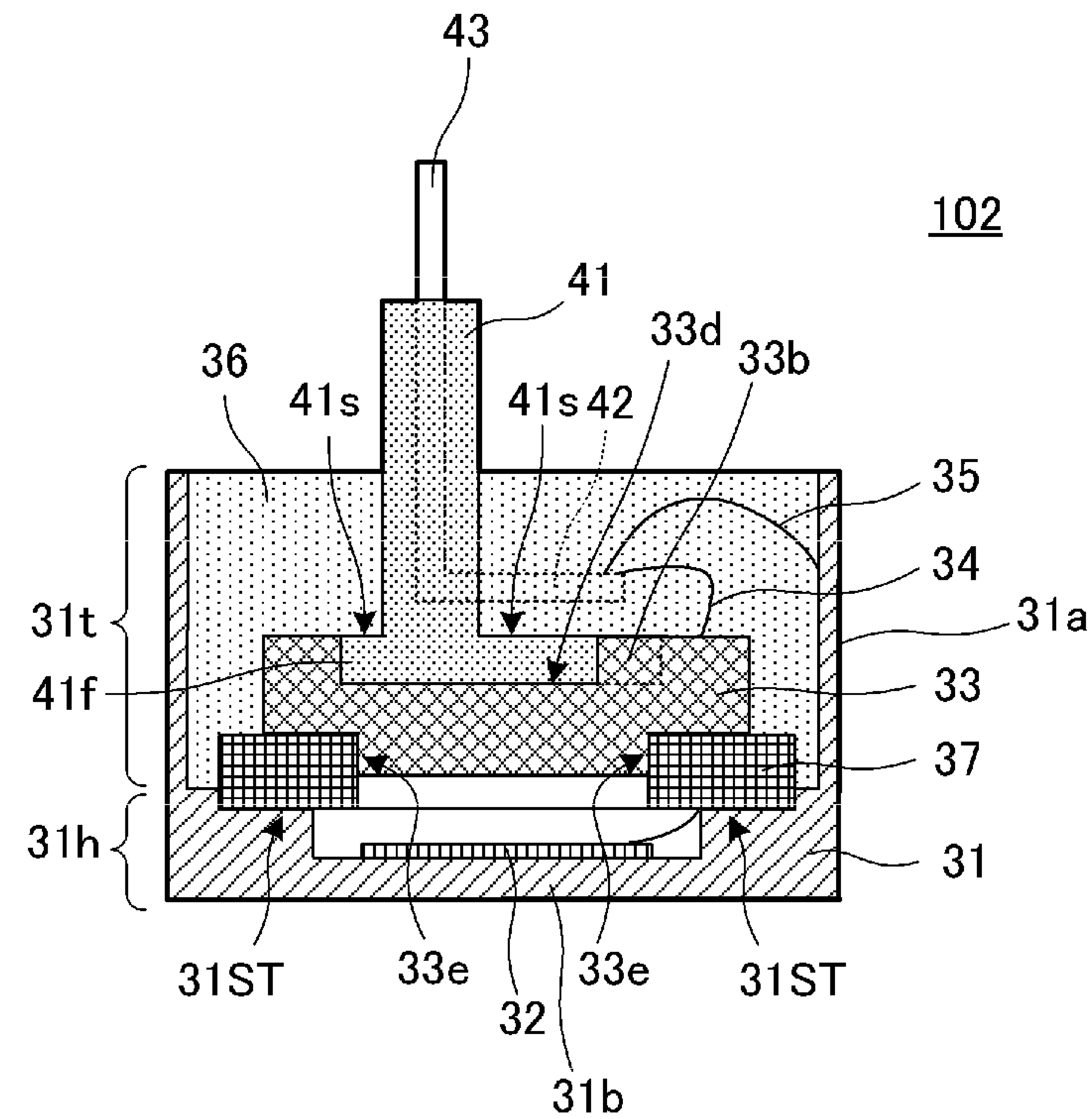


FIG. 5A


43
102
41
33d
33b
36
41s
41s
42
35
34
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41f
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37
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31
31ST
33e
33e
31ST
32
31b

FIG. 5B

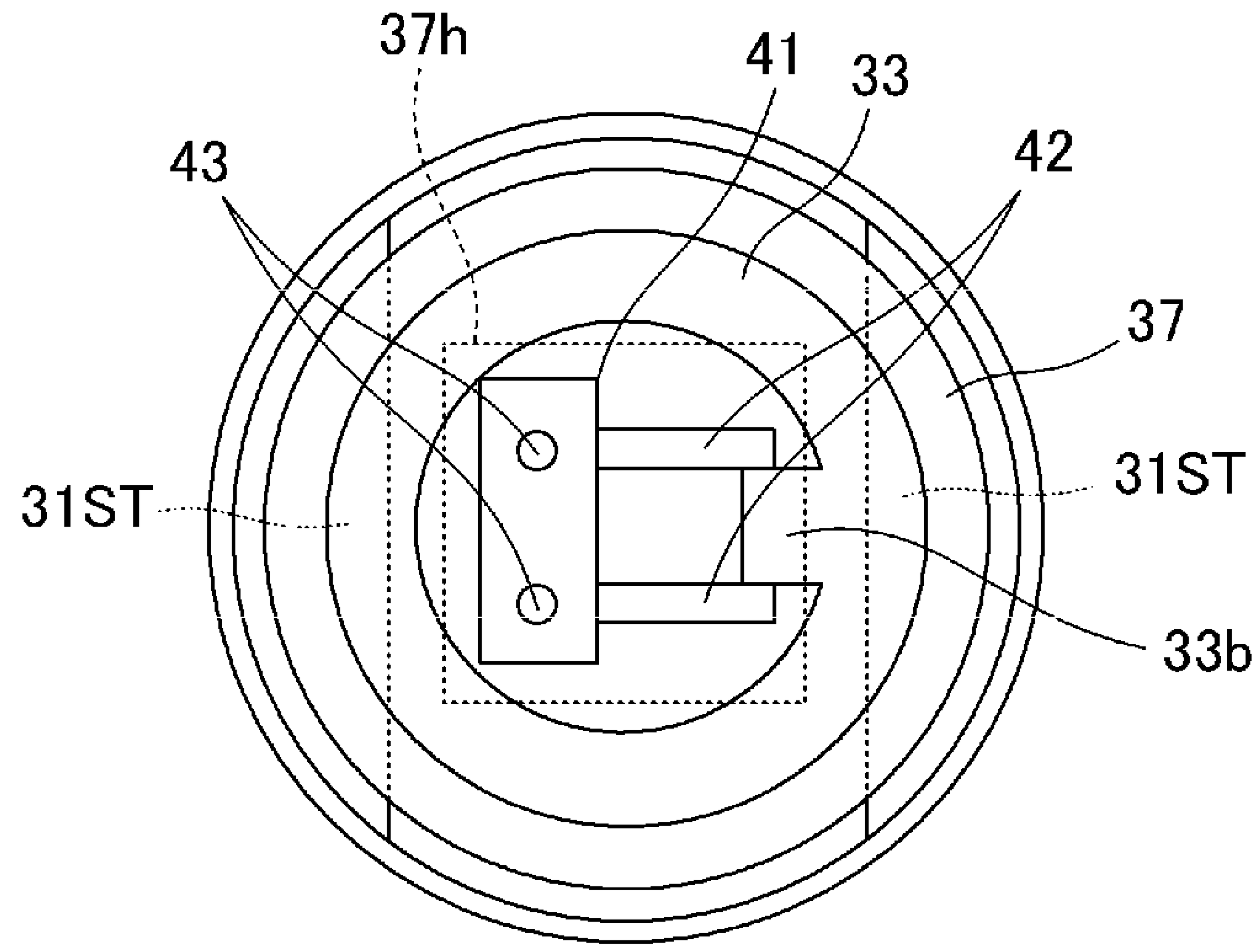

37h
41
33
43
42
37
31ST
31ST
33b

FIG. 6

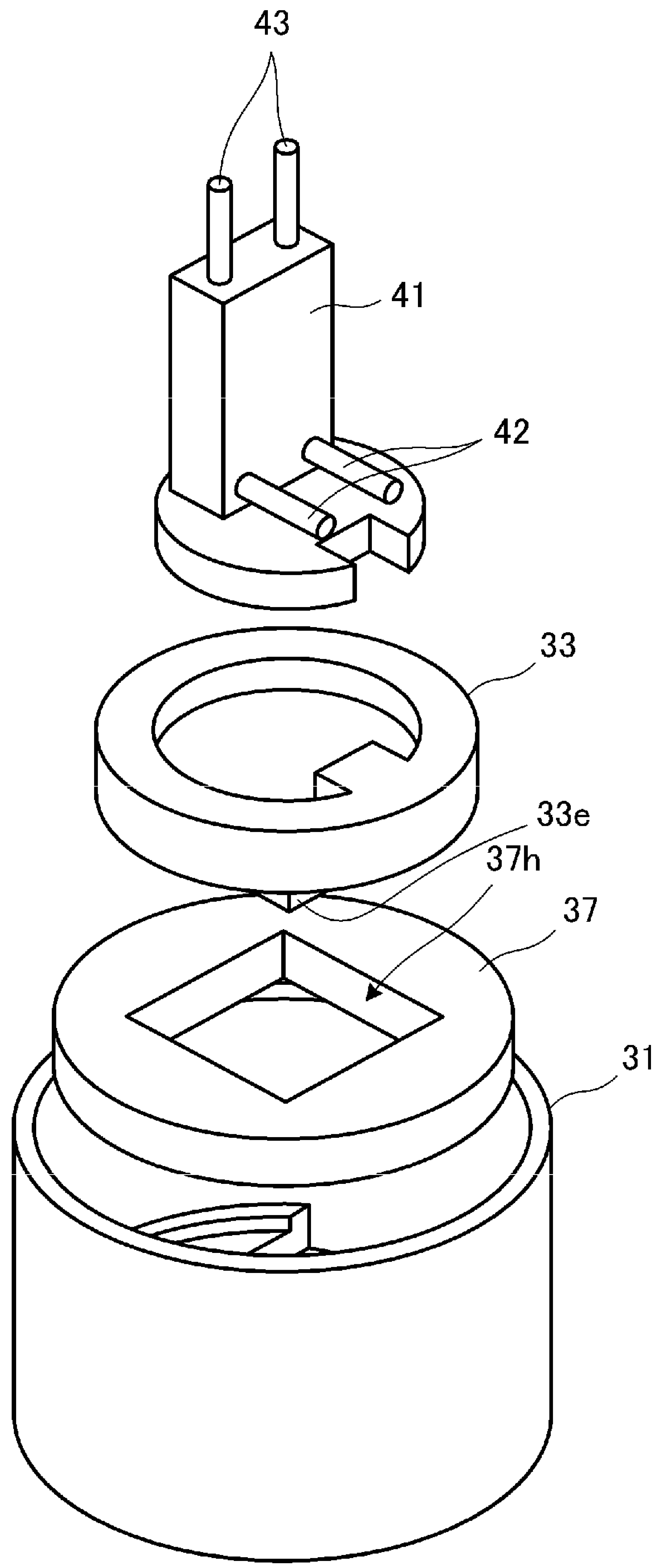


FIG. 7

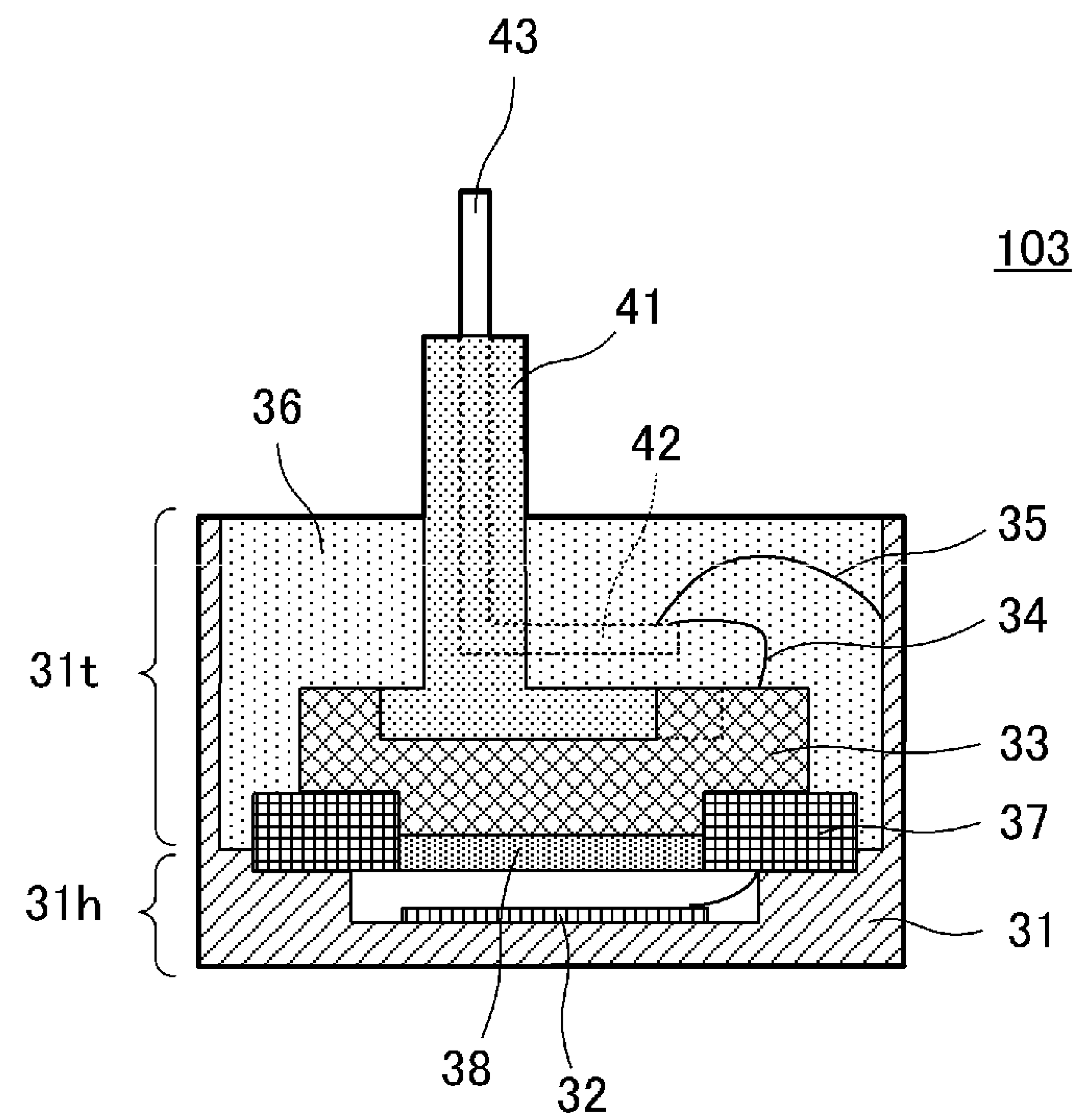
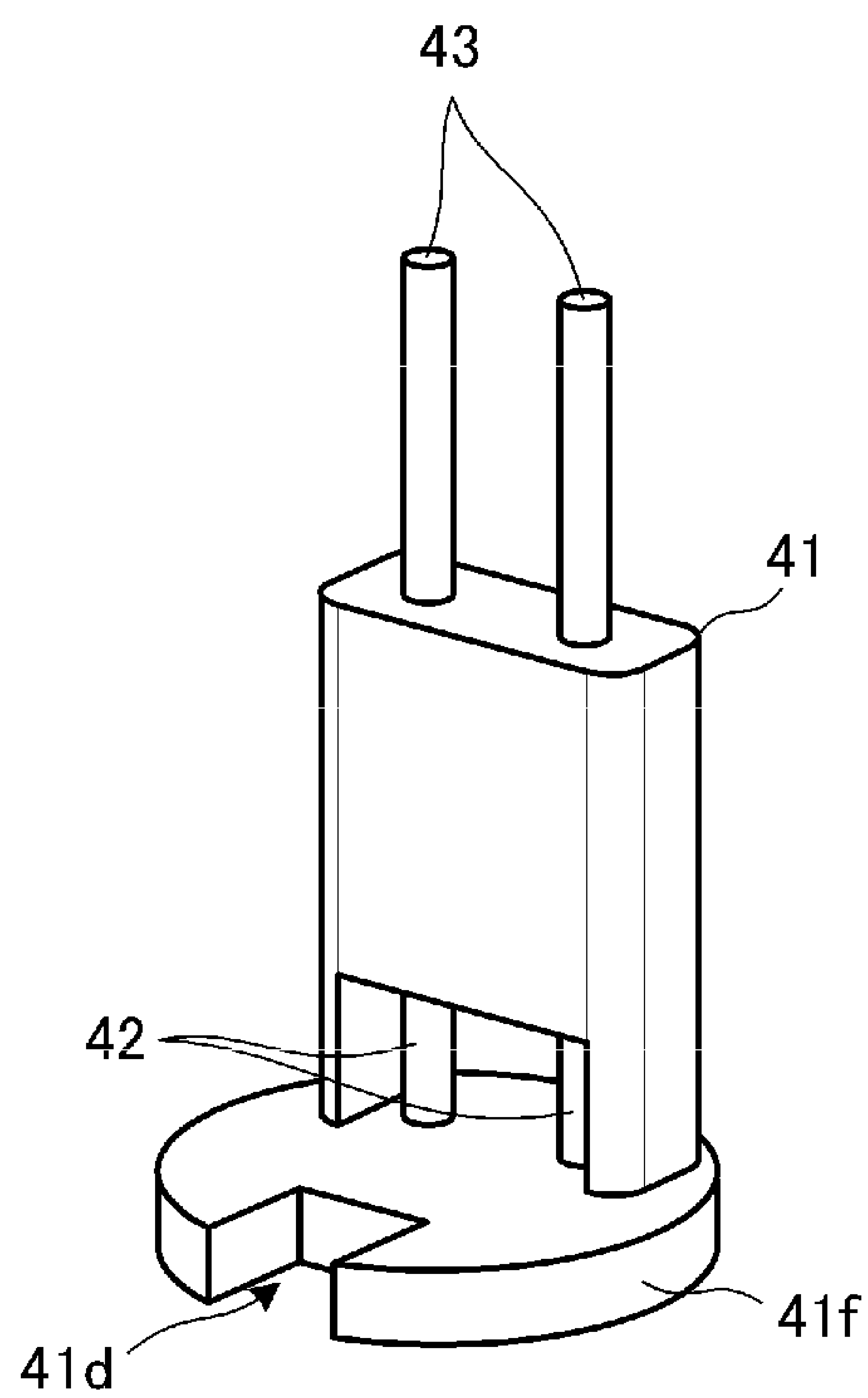


FIG. 8



ULTRASONIC SENSOR

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates to ultrasonic sensors. In particular, the present invention relates to an ultrasonic sensor which includes a piezoelectric element and input-output terminals electrically connected to the piezoelectric element and is used, for example, as a corner sonar or a back sonar of a car.

2. Description of the Related Art

An ultrasonic sensor is a sensor that uses ultrasonic waves to perform sensing. The ultrasonic sensor intermittently transmits ultrasonic pulse signals and receives reflected waves from surrounding obstacles to detect an object. For example, the ultrasonic sensor is used in a car as a corner sonar, a back sonar, or a parking spot sensor that detects a space between the car and an obstacle, such as a side wall, in parallel parking.

An ultrasonic sensor of this type is disclosed in Japanese Unexamined Patent Application Publication No. 2007-318742. FIG. **1** is a cross-sectional view of an ultrasonic sensor **10** disclosed in this document. The ultrasonic sensor **10** includes a case **12** having a bottom portion **14** and a tubular portion **16**. The bottom portion **14** is made of metal, such as aluminum, and has a closed surface. The tubular portion **16** is made of metal, such as zinc, and fitted into and bonded by an adhesive to the bottom portion **14**.

A piezoelectric element **18** is bonded, by a conductive adhesive, to an inner bottom of the bottom portion **14** of the case **12**.

First and second input-output terminals **20** and **22** made of metal are electrically connected to the piezoelectric element **18**. The first and second input-output terminals **20** and **22** are extracted from the inside to the outside of the case **12**. The first input-output terminal **20** is electrically connected to an electrode on an upper principal surface of the piezoelectric element **18**. The first input-output terminal **20** includes a spring terminal **20***a* having spring properties, a middle portion **20***b*, and a pin-like extraction portion **20***c*.

The second input-output terminal **22** is electrically connected, through the case **12**, to an electrode on a lower principal surface of the piezoelectric element **18**. The second input-output terminal **22** includes a connection portion **22***a*, a middle portion **22***b*, and an extraction portion **22***c*.

The first and second input-output terminals **20** and **22** are supported by a substantially columnar support member **24** made of insulating synthetic resin. The first and second input-output terminals **20** and **22** are embedded, at their middle portions **20***b* and **22***b*, in the support member **24** and secured to be integral with the support member **24**.

In the interior of the case **12**, the support member **24** is placed adjacent to the upper principal surface of the piezoelectric element **18** and secured to the tubular portion **16** of the case **12**.

In the case **12**, a damping member **26** is disposed on the closed surface where the piezoelectric element **18** is placed. In the interior of the case **12**, an opening side of the support member **24** is sealed with an expandable filler (not shown).

In the ultrasonic sensor **10** of related art illustrated in FIG. **1**, the support member **24** that supports the first and second input-output terminals **20** and **22** is directly attached to the tubular portion **16** that vibrates. As a result, vibrations of the tubular portion **16** are transmitted to the first and second input-output terminals **20** and **22** and vibrate a substrate on which the first and second input-output terminals **20** and **22** are mounted (hereinafter referred to as "vibration leakage").

This vibration leakage causes a long reverberation time (i.e., deteriorates reverberation characteristics). If reverberation is prolonged in detection of a nearby object, a reflected signal is received while reverberation of a transmission signal (burst wave) continues. This makes it difficult to detect a nearby object. Additionally, in the structure illustrated in FIG. **1**, where a boundary between the bottom portion **14** and the tubular portion **16** is exposed to a side face of the case **12**, it is necessary to take measures to prevent entry of moisture and corrosion under high humidity conditions.

An object of the present invention is to provide an ultrasonic sensor which has reverberation characteristics improved by preventing vibration leakage.

SUMMARY OF THE INVENTION

According to preferred embodiments of the present invention, an ultrasonic sensor includes a cylindrical case having a bottom and a side wall, a piezoelectric element attached to an inner bottom surface of the case, terminals extracted to the outside of the case, a terminal retainer configured to hold the terminals, and conductive members connected to the terminals and configured to feed power to the piezoelectric element. The side wall of the case has a thin portion adjacent to an opening of the case and a thick portion adjacent to the bottom of the case. The ultrasonic sensor further includes an elastic member disposed between the thick portion and the terminal retainer.

With this structure, vibrations from the case are attenuated in the elastic member and mostly prevented from being transmitted through the terminal retainer to the terminals. It is thus possible to significantly reduce vibration leakage that occurs when the terminals are mounted on a substrate.

An opening region surrounded by the thick portion may be covered with the elastic member. With this structure, sonic waves emitted from the piezoelectric element toward the interior of the case can be blocked from directly reaching the terminal retainer. It is thus possible to further reduce vibration leakage.

A space between the thin portion of the side wall and a side face of the elastic member may be filled with a filler. With this structure, the filler is in contact with the side wall of the case over a wide area. Therefore, as compared to a structure in which the thin portion and the elastic member are in contact with each other, vibrations in the side wall of the case can be suppressed and reverberation can be reduced.

A reinforcing member (weight) having an acoustic impedance higher than that of the case may be formed on the thick portion. This structure enhances rigidity of a portion around the inner bottom surface of the case, suppresses transmission of vibrations from the bottom to the side wall of the case, and thus improves sensitivity of the ultrasonic sensor.

A space may be created between the piezoelectric element and the elastic member, and a sound absorbing member may be provided on a surface of the elastic member adjacent to the piezoelectric element. With this structure, unwanted sonic waves are absorbed by the sound absorbing member. Therefore, it is possible to efficiently attenuate unwanted sonic waves transmitted from the piezoelectric element toward the interior of the case.

It may be preferable that the bottom of the case have stepped portions that produce anisotropy in a major axis direction and a minor axis direction, the elastic member have first engagement portions that engage with the respective stepped portions, the elastic member have a second engagement portion that engages with the terminal retainer, and the terminal retainer have an engagement portion that engages with the second engagement portion.

With this structure, where the case, the elastic member, and the terminal retainer are positioned with respect to each other, the terminals and the terminal retainer can be secured stably. To produce anisotropy in directivity of ultrasonic waves to be transmitted and received (i.e., to make a directivity angle in a vertical direction different from that in a horizontal direction), a thin portion with major and minor axes is typically created at the bottom of the case. However, the directivity of the thin portion cannot be identified from outside the case. Therefore, in related art, the terminal retainer is secured onto an end face of the case adjacent to the opening of the case. However, if the terminal retainer is secured onto the end face of the case, for example, entry of moisture through a boundary between the end face and the terminal retainer may cause degradation of sensitivity. In the structure described above, when the case, the elastic member, and the terminal retainer are brought into engagement with each other, the terminals are secured inside the case in accordance with the directional property of a vibrating surface of the case. Therefore, the directional property of the vibrating surface can be identified on the basis of the positions of the terminals exposed to the outside of the case.

According to the preferred embodiments of the present invention, vibrations from the case are attenuated in the elastic member and mostly prevented from being transmitted through the terminal retainer to the terminals. It is thus possible to significantly reduce vibration leakage that occurs when the terminals are mounted on a substrate. Therefore, deterioration of reverberation characteristics caused by vibration leakage can be prevented, and detection of a nearby object becomes possible.

Other features, elements, characteristics and advantages of the present invention will become more apparent from the following detailed description of preferred embodiments of the present invention with reference to the attached drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a cross-sectional view of an ultrasonic sensor disclosed in Japanese Unexamined Patent Application Publication No. 2007-318742.

FIG. **2**A is a cross-sectional view of an ultrasonic sensor according to a first embodiment of the present invention. FIG. **2**B is a plan view of a state before a case of the ultrasonic sensor of FIG. **2**A is internally filled with a filler.

FIG. **3** is an exploded perspective view illustrating a structure of the case, an elastic member, and a terminal retainer of the ultrasonic sensor according to the first embodiment.

FIG. **4**A is a graph showing reverberation characteristics of the ultrasonic sensor according to the first embodiment. FIG. **4**B is a graph showing reverberation characteristics of the ultrasonic sensor illustrated as a comparative example in FIG. **1**.

FIG. **5**A is a cross-sectional view of an ultrasonic sensor according to a second embodiment of the present invention. FIG. **5**B is a plan view of a state before the case of the ultrasonic sensor of FIG. **5**A is internally filled with a filler.

FIG. **6** is an exploded perspective view illustrating a structure of the case, a reinforcing member, the elastic member, and the terminal retainer of the ultrasonic sensor according to the second embodiment.

FIG. **7** is a cross-sectional view of an ultrasonic sensor according to a third embodiment of the present invention.

FIG. **8** is a perspective view illustrating shapes of the terminal retainer and the terminals included in an ultrasonic sensor according to a fourth embodiment of the present invention.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

First Embodiment

FIG. **2**A is a cross-sectional view of an ultrasonic sensor **101** according to a first embodiment of the present invention. FIG. **2**B is a plan view of a state before a case **31** of the ultrasonic sensor **101** is internally filled with a filler. The ultrasonic sensor **101** includes the case **31** of substantially cylindrical shape having a bottom **31***b* and a side wall **31***a*, a piezoelectric element **32** attached to an inner bottom surface of the case **31**, a terminal retainer **41** configured to hold outer terminals **43** and inner terminals **42**, and wires (conductive members) **34** and **35** connected to the inner terminals **42** and configured to feed power to the piezoelectric element **32**.

The side wall **31***a* of the case **31** has a thin portion **31***t* adjacent to an opening of the case **31** and a thick portion **31***h* adjacent to the bottom **31***b* of the case **31**. The bottom **31***b* of the case **31** has stepped portions **31**ST. Broken lines in FIG. **2**B indicate positions of the stepped portions **31**ST at the bottom **31***b* of the case **31**. An elastic member **33** is disposed between the thick portion **31***h* and the terminal retainer **41**. In other words, an opening region surrounded by the thick portion **31***h* is covered with the elastic member **33**.

A region surrounded by the stepped portions **31**ST (indicated by the broken lines in FIG. **2**B) at the bottom **31***b* of the case **31** and the inner periphery of the case **31** where the stepped portions **31**ST are not present is a main vibration region, which is substantially equivalent to the inner bottom surface of the case **31**. The main vibration region of the case **31** has a major (longer) axis corresponding to a direction parallel to the broken lines in FIG. **2**B and a minor (shorter) axis corresponding to a direction perpendicular to the broken lines in FIG. **2**B. Thus, since the main vibration region is anisotropic, anisotropy is produced in directivity of ultrasonic waves. Specifically, the directivity angle of ultrasonic waves is narrow in the major axis direction (i.e., the vertical direction in FIG. **2**B) and wide in the minor axis direction (i.e., the horizontal direction in FIG. **2**B).

The case **31** is internally filled with a filler **36** which is an elastic body made of silicon resin, urethane resin, or the like. The filler **36** is bonded to the inner surface of the case **31**. Since the opening region surrounded by the thick portion **31***h* is covered with the elastic member **33**, a space is created between the piezoelectric element **32** and the elastic member **33**.

Since the outside diameter of the elastic member **33** is smaller than the inside diameter of the thin portion **31***t* of the side wall **31***a* of the case **31**, the filler **36** is present between the thin portion **31***t* and the side face of the elastic member **33**.

The case **31** is, for example, an aluminum forged body. The elastic member **33** is an elastic molded body made of silicon rubber, urethane resin, or the like. First engagement portions **33***e* that engage with the respective stepped portions **31**ST of the case **31** are formed in the lower part of the elastic member **33**. A second engagement portion **33***d* with which the terminal retainer **41** engages is formed in the upper part of the elastic member **33**. The elastic member **33** is not open in the center.

The terminal retainer **41** is a molded body of resin, such as polybutylene terephthalate (PBT). The terminal retainer **41** holds about two pins, which serve as the outer terminals **43** at one end and the inner terminals **42** at the other end. The terminal retainer **41** has a flange-like engagement portion (hereinafter referred to as a "flange") **41***f* at a lower end thereof. The flange **41***f* engages with the second engagement portion **33***d* in the upper surface of the elastic member **33**. An upper surface **41***s* of the flange **41***f* of the terminal retainer **41** is covered with the filler **36**.

As described above, since there is the elastic member **33** between the thick portion **31***h* of the case **31** and the terminal retainer **41**, vibrations from the case **31** are attenuated in the elastic member **33** and mostly prevented from being transmitted through the terminal retainer **41** to the outer terminals **43**. It is thus possible to significantly reduce vibration leakage that occurs when the outer terminals **43** are mounted on a substrate. In particular, since the elastic member **33** is not open in the center, sonic waves emitted from the piezoelectric element **32** toward the interior of the case **31** hit the elastic member **33**, instead of directly hitting the terminal retainer **41**. Thus, sonic waves emitted from the piezoelectric element **32** toward the interior of the case **31** are attenuated in the elastic member **33**. Therefore, it is possible to effectively prevent vibration leakage.

Additionally, since the upper surface **41***s* of the flange **41***f* of the terminal retainer **41** is covered with the filler **36**, the terminal retainer **41** can be held firmly in place. Thus, the terminal retainer **41** is made more resistant to removal and peeling.

In terms of material nature, whereas the elastic member **33** is less prone to transmit vibrations, the filler **36** suppresses (damps) vibrations of the case **31**. That is, it is preferable that the elastic modulus of the elastic member **33** be lower than that of the filler **36**. More specifically, the elastic modulus can be divided into a storage modulus and a loss modulus. The elastic member **33** preferably has a lower storage modulus, and the filler **36** preferably has a higher loss modulus. For example, the elastic member **33** is preferably made of silicon resin (silicon rubber), and the filler **36** is preferably made of urethane resin.

As described above, a space between the thin portion **31***t* of the side wall **31***a* of the case **31** and the side face of the elastic member **33** is filled with the filler **36**. Since the filler **36** is bonded to the side wall **31***a* of the case **31** over a wide area (large depth range), the vibration damping effect of the side wall **31***a* of the case **31** is improved. It is thus possible to reduce reverberations.

FIG. **3** is an exploded perspective view illustrating a structure of the case **31**, the elastic member **33**, and the terminal retainer **41** of the ultrasonic sensor **101**. As described above, to make the main vibration region of the case **31** anisotropic, the case **31** has a pair of the stepped portions **31**ST at the bottom **31***b*. FIG. **3** shows only one of the stepped portions **31**ST. In the lower part of the elastic member **33**, there is a pair of the first engagement portions **33***e* that engage with the respective stepped portions **31**ST at the bottom **31***b* of the case **31**. In the upper part of the elastic member **33**, there is the second engagement portion **33***d* with which the flange **41***f* of the terminal retainer **41** engages. A protrusion **33***b* is formed in a part of the second engagement portion **33***d*.

A recess **41***d* with which the protrusion **33***b* of the elastic member **33** engages is formed in a part of the flange **41***f* of the terminal retainer **41**.

The first engagement portions **33***e* of the elastic member **33** engage with the stepped portions **31**ST of the case **31**, and the flange **41***f* of the terminal retainer **41** engages with the second engagement portion **33***d* of the elastic member **33**. Thus, by sequentially bringing these three parts into engagement, the orientation of the terminal retainer **41** with respect to the case **31** becomes stable. Therefore, even when the terminal retainer **41** is not positioned on the end face of the case **31** adjacent to the opening, the directional property of a vibrating surface of the case **31** can be identified by the positions of the outer terminals **43** exposed to the outside of the case **31**.

If the case **31**, the elastic member **33**, and the terminal retainer **41** are temporarily secured to each other by engagement of the stepped portions **31**ST with the first engagement portions **33***e* and by engagement of the second engagement portion **33***d* with the flange **41***f*, the filler **36** can be easily placed in the case **31**.

Since the about two pins (which serve as the outer terminals **43** at one end and the inner terminals **42** at the other end) held by the terminal retainer **41** are molded into a substantially L-shape, there is a large space around the inner terminals **42** before the case **31** is filled with the filler **36**. This allows easy connection of wires to the inner terminals **42**.

FIG. **4**A is a graph showing reverberation characteristics of the ultrasonic sensor **101** according to the first embodiment. FIG. **4**B is a graph showing reverberation characteristics of the ultrasonic sensor **10** illustrated as a comparative example in FIG. **1**. In the graphs, each division of the horizontal axis represents about 500 μs and each division of the vertical axis represents about 1 V. In both the first embodiment and the comparative example, the outer terminals were secured onto a substrate (not shown) by soldering, about eight burst waves were transmitted during the transmission time, and a voltage waveform appearing in the piezoelectric element was amplified and observed. Although attenuation of amplitude actually started immediately after the end of transmission, the waveform was saturated for a while, during which the dynamic range of the amplifying circuit was exceeded.

As is apparent from the comparison between FIG. **4**A and FIG. **4**B, in the ultrasonic sensor **101** of the first embodiment where the amplitude converges faster, vibration leakage and reverberations are suppressed.

In the first embodiment, unlike the structure of FIG. **1**, no boundary is present in the outer periphery of the case **31**. Therefore, it is possible to prevent degradation of sensitivity caused by entry of water through such a boundary, and to prevent corrosion between different metals.

Second Embodiment

FIG. **5**A is a cross-sectional view of an ultrasonic sensor **102** according to a second embodiment of the present invention. FIG. **5**B is a plan view of a state before the case **31** of the ultrasonic sensor **102** is internally filled with the filler **36**.

The ultrasonic sensor **102** includes a reinforcing member (weight) **37** on the thick portion **31***h* of the case **31**. The reinforcing member **37** is located at a position not in contact with the inner periphery of the thin portion **31***t* of the side wall **31***a*. The reinforcing member **37** may be any molded body with high acoustic impedance. For example, a molded body made of the same material as that of the case **31** (aluminum) may be used as the reinforcing member **37** by adjusting the size, such as the thickness. However, it is preferable that the reinforcing member **37** be a molded body made of material (such as stainless steel (SUS) or zinc) higher in density than that of the material of the case **31**. Broken lines in FIG. **5**B indicate positions of the stepped portions **31**ST at the bottom **31***b* of the case **31**. A region surrounded by the stepped portions **31**ST (indicated by the broken lines in FIG. **5**B) at the bottom **31***b* of the case **31** and the inner periphery of the case **31** where the stepped portions **31**ST are not present is a main vibration region, which is substantially equivalent to the inner bottom surface of the case **31**. The main vibration region of the case **31** is longer in a direction parallel to the broken lines in FIG. **5**B and shorter in a direction perpendicular to the broken lines in FIG. **5**B. Thus, anisotropy is produced in directivity of ultrasonic waves.

FIG. **6** is an exploded perspective view illustrating a structure of the case **31**, the reinforcing member **37**, the elastic member **33**, and the terminal retainer **41** of the ultrasonic sensor **102** illustrated in FIG. **5**A. The reinforcing member **37** is a substantially annular molded body having a substantially rectangular opening **37***h* in the center thereof. In the lower part of the elastic member **33**, there are the first engagement portions **33***e* that engage with the opening **37***h* of the reinforcing member **37**. The other configuration is the same as that described in the first embodiment.

The effect of the reinforcing member **37** enhances rigidity of a portion around the inner bottom surface of the case **31**. This can not only suppress transmission of vibrations from the bottom **31***b* to the side wall **31***a* of the case **31**, but can also allow the bottom **31***b* (vibrating surface) of the case **31** to efficiently vibrate. The sensitivity of the ultrasonic sensor **102** can thus be improved.

Since the opening **37***h* of the reinforcing member **37** and the first engagement portions **33***e* of the elastic member **33** are substantially noncircular, it is possible to maintain the directional property of the terminal retainer **41** with respect to the case **31**.

Third Embodiment

FIG. **7** is a cross-sectional view of an ultrasonic sensor **103** according to a third embodiment of the present invention. The ultrasonic sensor **103** includes the case **31**, the piezoelectric element **32**, the terminal retainer **41** that holds the outer terminals **43** and the inner terminals **42**, the wires (conductive members) **34** and **35** connected to the inner terminals **42** and configured to feed power to the piezoelectric element **32**, the reinforcing member **37**, a sound absorbing member **38**, and the filler **36**. The ultrasonic sensor **103** is obtained by adding the sound absorbing member **38** to the lower surface of the elastic member **33** (i.e., the surface adjacent to the piezoelectric element **32**) of the ultrasonic sensor **102** illustrated in FIG. **5**A. The sound absorbing member **38** is, for example, a polyester felt and is bonded to the elastic member **33** by an adhesive.

As described above, since the sound absorbing member **38** is provided on the lower surface of the elastic member **33** adjacent to the piezoelectric element **32**, unwanted sonic waves are absorbed and attenuated by the sound absorbing member **38** before reaching the elastic member **33** and being attenuated inside the elastic member **33**. Therefore, it is possible to efficiently attenuate unwanted sonic waves transmitted from the piezoelectric element **32** toward the interior of the case **31**. Also, positioning of the sound absorbing member **38** can be easily made.

Fourth Embodiment

FIG. **8** is a perspective view illustrating shapes of the terminal retainer **41** and the inner and outer terminals **42** and **43** included in an ultrasonic sensor according to a fourth embodiment of the present invention. About two pins held by the terminal retainer **41** serve as the outer terminals **43** at one end and the inner terminals **42** at the other end. As illustrated in FIG. **8**, it is not necessary that the inner terminals **42** be bent inside the terminal retainer **41**, as long as they are exposed to allow connection of wires thereto.

While preferred embodiments of the invention have been described above, it is to be understood that variations and modifications will be apparent to those skilled in the art without departing from the scope and spirit of the invention. The scope of the invention, therefore, is to be determined solely by the following claims.

What is claimed is:

1. An ultrasonic sensor comprising:

a case including a bottom portion and a side wall portion that define an inner space, wherein the side wall portion of the case has a thin portion defining an opening of the case and a thick portion defining the bottom portion of the case;

a piezoelectric element located within the inner space of the case and adjacent to the bottom portion of the case;

a terminal positioned within the inner space of the case and extending outside the case;

a terminal retainer configured to hold the terminal;

a conductive member connecting the terminal to the piezoelectric element; and

an elastic member disposed between the thick portion and the terminal retainer,

wherein the thick portion includes a step and the elastic member has an engagement portion that engages with the step of the thick portion.

2. The ultrasonic sensor according to claim **1**, wherein the case is a substantially cylindrical case.

3. The ultrasonic sensor according to claim **1**, wherein an opening region in the thick portion is covered with the elastic member.

4. The ultrasonic sensor according to claim **1**, further comprising a filler located within a space between the thin portion of the side wall portion and a side surface of the elastic member.

5. The ultrasonic sensor according to claim **4**, wherein the elastic member has an elastic modulus lower than an elastic modulus of the filler.

6. The ultrasonic sensor according to claim **1**, wherein the elastic member has a second engagement portion that engages with the terminal retainer.

7. The ultrasonic sensor according to claim **1**, further comprising a reinforcing member positioned between the thick portion and the elastic member.

8. The ultrasonic sensor according to claim **7**, wherein reinforcing member has an acoustic impedance higher than that of the case.

9. The ultrasonic sensor according to claim **1**, further comprising a sound absorbing member on a surface of the elastic member adjacent to the piezoelectric element.

10. The ultrasonic sensor according to claim **1**, wherein

the step is configured to produce anisotropy in a major axis direction and a minor axis direction;

the elastic member has a second engagement portion that engages with the terminal retainer; and

the terminal retainer has a flange that engages with the second engagement portion.

11. The ultrasonic sensor according to claim **1**, wherein the terminal includes a bent terminal portion within the inner space of the case.

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